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# Historical manufacturing volatility and local sustainability efforts: A link to the past

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ABSTRACT

Renewed attention to the role of subnational efforts in addressing myriad environmental challenges necessitates a greater understanding of the factors associated with program adoption. Given observed relationships between adoption of sustainability practices and the presence of carbon-intensive industry, and separately the observed persistence of industrial history in a given place, we explore the link between historical manufacturing employment volatility and current sustainability plan adoption at the local level. Our analysis suggests that the magnitude of changes in manufacturing employment is inversely related to the likelihood of sustainability plan adoption. Our analysis further suggests that, given the same pace of change, counties with shrinking manufacturing employment are more likely to adopt sustainability plans than those with growing employment. Lastly, we find that the link between past industrial transitions and local sustainability commitment is moderated by local disaster experience and priority for environmental protection. Collectively, the findings also shed light on potential—and otherwise unobservable—barriers to transitions to sustainable practices at the local level. In particular, the inverse relationship between pace of employment change and plan adoption suggests that minimizing the rapidity of contemporary transitions may counterintuitively ease the eventual adoption of sustainability-related policies.

## 1. Introduction

The scale and magnitude of climate change and its attendant effects present environmental, economic, human health, and management challenges at all levels of government (IPCC, 2021). Though some have argued that local efforts to combat climate change and to achieve sustainability may be ineffective absent action at broader scales (Betsill, 2001; Engel and Orbach, 2008; Fuhr et al., 2018), the present political environment in both the U.S. and aboard has nonetheless placed increased emphasis on action at the subnational level (Arroyo, 2017; Ba and Galik, 2019; Galik et al., 2017; Rabe and Mills, 2017). Better understanding the factors associated with sustainability commitments at the local level is therefore of the utmost importance.

Efforts to promote sustainability at the local level can be thought of as including policies, programs, and agreements specifically tailored to address not only climate change (e.g., U.S. Conference of Mayor's Climate Protection Agreement), but also a wider array of sustainability initiatives seeking to reduce resource use or increase resource efficiency (e.g., ICLEI-Local Governments for Sustainability). Past analyses of local adoption of various sustainability, environmental, or climate commitments have found, for example, association between a variety of demographic, geographic, structural, economic, and environmental attributes. Relevant factors include considerations such as cost savings (Kousky and Schneider, 2003; Sharp et al., 2011), community affluence or resources (Krause, 2011; Lubell et al., 2009; Zahran et al., 2008a), population (Krause, 2011; Yi et al., 2017), education (Brody et al., 2008; Krause, 2011; Krause et al., 2016; Zahran et al., 2008b), community activism (Brody et al., 2008; Sharp et al., 2011; Zahran et al., 2008a), political alignment (Krause, 2011; Krause et al., 2016), political institutions and administrative structure (Krause, 2011; Yi et al., 2017), similar actions by other local governments in the area (Krause, 2011; Yi et al., 2017), perceived problem severity (Brody et al., 2008), and compatibility with other environmental or economic objectives (Kousky and Schneider, 2003; Yi et al., 2017).

Likewise explored are the relationships between manufacturing in a given location and participation in renewable energy, climate planning, and greenhouse gas reduction endeavors. For instance, Zahran et al. (2008a, 2008b) and Brody et al. (2008) suggest that participation in

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ICLEI-USA's Cities for Climate Protection program might be diminished in part by higher concentration of carbon-based industry (i.e., agriculture, manufacturing, mining, construction), with the latter study finding evidence of such a trend. Matisoff (2008) explores a similar relationship between the presence of carbon intensive industry and the adoption of energy efficiency and renewable energy policies at the state level, while Krause (2011) finds a negative relationship between value added by manufacturing and the decision by a city to participate in the U.S. Conference of Mayor's Climate Protection Agreement.

While such analyses are instrumental in increasing our understanding of the decision-making process at the local government level, contributions from a broader literature point to the possibility of more complex, historical factors associated with the decision to undertake sustainability commitments at the subnational level (see Roberts et al., 2018). For example, Betsill (2001) assesses the connection between sustainability programing and previous environmental engagement by municipalities, suggesting the influence of drivers not wholly captured in contemporary data. The question thus arises as to what else might be associated with present-day decision-making and why.

With an eye to findings from Betsill (2001), Brody et al. (2008), Krause (2011), Matisoff (2008), and Zahran et al. (2008a), we explore here the connection between past industrial activity and present-day sustainability commitment. The U.S. economy has undergone substantial transitions over the last several decades, moving increasingly towards a service-based economy (e.g., Buera and Kaboski, 2012). Given the importance of framing sustainability and climate action in terms of local interests and priorities (Betsill and Bulkeley, 2007; Sharp et al., 2011; Shaw et al., 2014), the importance of so-called place-specific norms and values in understanding the geography of sustainability transitions (Hansen and Coenen, 2015, p. 98), and the persistence of local heritage, particularly the role of industrial history, in defining those norms, values, interests, and priorities (e.g., Byrne, 2002; Linkon, 2018), we might expect that the *manner* in which such industrial transitions have occurred would have a lingering influence on present-day behavior.

To frame our analysis, we draw broadly from the historical institutionalism literature (e.g., Lockwood et al., 2016; Pierson, 2000; Roberts and Geels, 2019; Thelen, 1999) and industrial transition scholarship (e.g., Byrne, 2002; Cowie and Heathcott, 2003; Linkon and Russo, 2002; Olsthoorn and Kuik, 2006). These literatures provide the justification for our exploratory hypotheses, that direction and rate of industrial transitions over the last 50 years (measured in terms of manufacturing employment) are associated with present-day sustainability plan adoption. In developing our argument, we contribute to the literature in two separate ways. First, we highlight the relevance of historical precedents in contemporary sustainability action at the local level. This is an important development over the existing literature both conceptually and methodologically. Yi et al. (2017), for example, lag economic development expenses and growth management planning in their model of climate program adoption, but only by one year; developing a mechanism to consider the relationship between present-day climate and sustainability commitment and longer-term indicators of individual community history and identity is thus an important contribution.

Second, the analysis seeks to provide a bridge between analysis traditionally undertaken in the environmental sphere with related research in the industrial transition and development arena. For instance, worker retraining programs may seek to ease the transition of communities or individuals affected by economic change by offering education and retraining programs (Louie and Pearce, 2016; Pollin and Callaci, 2019). Indeed, the prospect of a transition to clean energy and other green jobs is at the core of recent proposals to overhaul the economy in the name of green growth and sustainable development (e.g., Jaeger et al., 2021; Lockwood et al., 2019; Roberts et al., 2018). By highlighting the more complicated social context in which transitional policies and programs are to be implemented, the analysis contributes to a broader understanding of the institutional context in which decision-making occurs at the local level.

Below, the article first provides a theoretical frame for the analysis. It then elaborates four hypotheses with regard to the lingering effect of historical industrial transitions on current sustainability commitments at the local level as well as to the moderating effects of local priority and disaster experience. Next, the variables, measures, data sources utilized are presented. This is followed by the empirical analysis and reporting of the results, including output from regression analysis and average marginal effects (AMEs). The article concludes with a discussion of their implications for broader sustainability and climate program development at the local level.

## 2. Theory and hypotheses

Political decision-making is influenced by institutions, defined to include "the formal or informal procedures, routines, norms, and conventions embedded in the organizational structure of the polity or political economy" (Hall and Taylor, 1996, p. 938). Together, such institutions affect decision-maker behavior by influencing preferences, framing choices, and establishing expectations (Hall and Taylor, 1996; Thelen, 1999). Within the spectrum of institutional theories, New Institutionalism (NI) provides a tractable approach for exploring the influence of institutions in environmental policy and research. An inherent strength of NI is that it "draws attention to the interplay between the regulatory system and the social system at large, providing insights for developing both regulation and the practices of environmental management" (Raitio, 2012, p. 309–310).

Within the broader field of NI, Historical Institutionalism (HI) has been touted for its "substantial appeal as a central organizing approach for explaining politics and policy" (Peters et al., 2005, p. 1282). It has been described as inductive, parsimonious, agreeable with real-world observations, and particularly amenable to comparative analysis (Diermeier and Krehbiel, 2003; Hall and Taylor, 1996; Peters et al., 2005; Thelen, 1999). HI has also been cited as having particular advantages in the assessment of sustainable energy transitions, especially when used as a complement to more traditional socio-technical systems analysis approaches, owing to the broader scope and methodological diversity that HI provides (Lockwood et al., 2016). For instance, HI has been used to study incumbent power and structural dependency in low-carbon transitions (see Lockwood et al., 2019; Lockwood et al., 2020), conditions for and patterns of politically accelerated transitions (see Roberts and Geels, 2019), as well as turning points of change and associated transition risk (see Walwyn, 2020).

One area of emphasis in HI is the inherent path dependency of institutions, or the imprinting influence of prior "institutional, economic, political, social, and cultural features" (Greif, 1998, p. 82. See also Hall and Taylor, 1996; Thelen, 1999). These "inherited" features affect both current and future preferences and constrain the opportunities presented to affected individuals and organizations through a combination of increasing returns, self-reinforcement, positive feedbacks, or lock-in (O'Riordan and Jordan, 1999, p. 83). In this way, institutions may be further perpetuated by both active and passive mechanisms, even in the face of external pressure for change (Aklin and Urpelainen, 2013; Galik and Chelbi, 2021; Lockwood et al., 2016; Roberts et al., 2018).

Path dependency may have particular salience to subnational policymaking (Burch, 2010; Kuzemko et al., 2016). As noted above, research has already explored the potential connection between contemporary industrial activity and the adoption and composition of local environmental programming (e.g., Brody et al., 2008; Fisk, 2013; Fisk et al., 2017; Krause, 2011; Matisoff, 2008; Zahran et al., 2008a). This line of research is well-suited to capture many of the institutional, economic, and political determinants of path dependency (sunk costs, existence of complementary infrastructure, presence of a specialized workforce, etc.), but less suited to capture lingering social or community features stemming from historical movements such as *past* industrial transitions. This is because such features are often transmitted across generations

and disentangling them requires a careful examination of historical precedents and dynamics (Glaeser, Kerr, and Kerr, 2015).

The question explored here is whether and to what extent past industrial transitions are associated with contemporary sustainability commitments, a relationship that is commonly referred to but rarely tested in the environmental policy and management scholarship (Skellern et al., 2017). Specifically, we assess the potential relationship between past industrial transitions (i.e., change in industrial concentration and magnitude of manufacturing job loss) and local governments' sustainability commitment in the U.S. In doing so, we consider two dimensions of past industrial transitions. The first is historical trend, which categorizes industrial transitions by *direction*. Specifically, three possible directions are identified: no change, descending, and ascending, representing unfluctuating, shrinking, and growing industrial concentration in a given locality, respectively. The second dimension is historical dispersion, which considers the *magnitude* of past transitions, or the amount of variation or volatility observable in local industrial concentration over time. Both dimensions are identified as key parameters in assessing industrial transitions (see Hess, 2014; Olsthoorn and Kuik, 2006; Kern and Rogge, 2016).

Here, we focus on these two dimensions because they help distinguish possible scenarios in which past industrial transitions can take place, scenarios that often have important implications for sustainability. For instance, while transitioning to a service-based economy with less dependence on manufacturing (i.e., the same direction), places with different transitioning magnitudes might encounter different tradeoffs between management and societal gains (e.g., gradual transitioning to allow room for regulative adjustment and workforce retraining) and continuing environmental harms (e.g., slower reductions of greenhouse gas emissions; see Hess, 2014; Kern and Rogge, 2016). Our assessment of historical trend is thus intended to investigate whether a connection exists between past industrial transitions and present-day sustainability commitments at the local level, whereas historical dispersion depicts the extent to which such a connection holds at varied rates of change. Previous studies suggest that, in general, a negative relationship exists between the presence of carbon-intensive industry and local sustainability commitment (see Brody et al., 2008; Krause, 2011; Matisoff, 2008; Zahran et al., 2008a). Research has also demonstrated that community connection with its industrial base may extend long past the loss of the industry itself (Linkon, 2018). Following their guidance and based on the literature reviewed above on HI regarding the lingering effect of historical industrial transitions, we hypothesize that:

**Hypothesis 1**. The direction of past industrial transitions is inversely related to local sustainability commitments in the U.S.

**Hypothesis 2**. The magnitude of past industrial transitions is inversely related to local sustainability commitments in the U.S.

We also can expect that any decision to adopt a sustainability plan will be moderated by more contemporary experiences in a given community. A growing line of research that applies institutionalism, and in particular HI, to sustainable policymaking has posited that, incumbent actors are advantaged and can enable or frustrate present-day policymaking based on their personal preferences, preferences that are likewise subject to historical feedback (Lockwood et al., 2019; Lockwood et al., 2020; Roberts et al., 2018). Additionally, the literatures on agenda setting (e.g., Baumgartner and Jones, 2010; Kingdon, 2011) and the budgetary process (e.g., Bäck et al., 2017; Natchez and Bupp, 1973) both have contended that government priorities condition its behavior and decision-making given inherently limited attention and resources. This conditioning effect has been validated in numerous studies on policy diffusion and adoption (e.g., Ho and Ni, 2004; Krause, 2011; Lubell et al., 2009).

It is therefore reasonable to expect that a government's contemporary priorities would condition the lingering effect of historical movements on its present decision-making. The conditioning effect of governments' priority is likely more saliant at the local level considering the increased fiscal stress facing local governments (Kim and Warner, 2018). This is particularly the case in the environmental sphere given the politicized and contentious nature of policy deliberations on the topic and the large amount of attention and resources potentially associated with commitment to prolonged sustainability efforts (see Aklin and Urpelainen, 2013; Ba, 2021). Together, the evidence presented above leads to the following hypothesis:

**Hypothesis 3**. Local governments' priority moderates the relationship between past industrial transitions and present-day sustainability commitments.

Along this line, the literature on disaster management and sustainability suggests that disaster experience is also likely to moderate the relationship between past industrial transitions and present-day sustainability commitments. First, disaster experience has been found to contribute to the adoption of sustainable programming (Garcia et al., 2019) and help raise public awareness and disaster preparedness (Hoffmann and Muttarak, 2017), important conditions for action and commitment at the local level (see Konisky et al., 2008; Zahran et al., 2008a). After a disaster, it is also arguably more likely for citizens who have lived with carbon-intensive industries to support solutions to environmental problems as their own experience with such industries might render them more vigilant to negative environmental externalities (Skellern et al., 2017). Second, disaster experience helps to justify the legitimacy of climate and sustainability action in pertinent political and policy discourses (Islam et al., 2020). This is particularly the case in communities that are currently transitioning to a more sustainable economy as disaster experience enables relevant policy agents and entrepreneurs to combine the imperative of mitigating risks of similar disasters in the future with the prosperity of local economy (Brundiers, 2018). As such, the information presented above leads to our last hypothesis:

**Hypothesis 4**. Local governments' disaster experience moderates the relationship between past industrial transitions and present-day sustainability commitments.

## 3. Variables, measurement, and data

The current analysis relies on publicly available data from numerous sources (see Table 1). First, to operationalize our dependent variable, local governments' sustainability commitments, we use responses to the question: "Has your jurisdiction adopted a sustainability plan?" in the Local Government Sustainability Practices (LGSP) survey conducted by the International City/County Management Association (ICMA) in 2015. The LGSP survey depicts how local governments engage issues of sustainability on topics such as water, energy, recycling, and policy actions (ICMA, 2015). Specifically, we set a dichotomous variable to 1 if a local government responded "yes" and 0 if "no."

We focus our sample on county governments for two reasons. First, compared to the groundswell of studies focusing on city and municipal level sustainability action (see e.g., Betsill, 2001; Engel and Orbach, 2008; Fuhr et al., 2018; Harlan and Ruddell, 2011; Kousky and Schneider, 2003; Krause et al., 2016), efforts at the county level are understudied. Yet relative to states and cities, counties are more suitable units for capturing labor market dynamics and associated sustainable transitions. This is because counties represent the largest possible geographical units in which most residents live, commute, and work, and many community development policies and intergovernmental programs are administered through county government (Lobao et al., 2012; Partridge and Rickman, 2006). Additionally, both urban and rural areas can be found within county jurisdictions, permitting a relatively more comprehensive view of different socio-economic demographics and transitioning patterns (Desmet and Fafchamps, 2005). Focusing on county governments thus help complement our understanding of local

**Table 1**
Variables, Measurements, Descriptive Statistics, and Data Sources.

| Variable | Measurement | Obs | Mean | S.D. | Min | Max | Source |
|---|---|---|---|---|---|---|---|
| **Dependent Variable** | | | | | | | |
| Sustainability plan adoption | If a county has adopted a sustainability plan (1 if yes; 0 if not) | 320 | 0.35 | 0.48 | 0 | 1 | a |
| **Independent Variables** | | | | | | | |
| Historical Trend | A categorical variable based on the Mann-Kendall statistics (MKS) (0 if no trend; 1 if descending trend; 2 if ascending trend) | 320 | 1.07 | 0.44 | 0 | 2 | b |
| Historical Dispersion | Standard deviation of the percentages of the number of manufacturing jobs to the number of total jobs each year in a county (1969–2016) (*100) | 320 | 4.50 | 3.10 | 0.34 | 18.43 | b |
| **Moderating Variables** | | | | | | | |
| Environmental priority | If environmental protection is a priority (1 if yes; 0 if not) | 320 | 0.45 | 0.50 | 0 | 1 | a |
| Disaster Experience | If a county has had to respond to a major disaster in the past 15 years (1 if yes; 0 if not) | 320 | 0.84 | 0.36 | 0 | 1 | a |
| **Control Variables** | | | | | | | |
| Population size | Population size (log) | 320 | 10.94 | 1.40 | 7.90 | 16.13 | c |
| Per capita income | Per Capita Personal Income (log) | 320 | 10.64 | 0.24 | 10.02 | 12.23 | d |
| Education | % of bachelor's degree or higher | 320 | 24.08 | 10.06 | 7.2 | 58.1 | e |
| Manufacturing Value Added | Manufacturing Value Added by County (in $1,000, log) | 289 | 12.50 | 1.85 | 6.57 | 18.02 | f |
| Air Quality | Average Particulate matter under 2.5 μm in aerodynamic diameter (PM2.5) | 320 | 9.86 | 2.40 | 4.42 | 15.34 | g |
| Election | 2016 Presidential General Election Returns by County (% Dem.) | 320 | 35.04 | 14.98 | 7.8 | 82.2 | h |
| Minority | % of minority (% non-white) | 320 | 15.64 | 13.95 | 0.3 | 82.2 | e |

*Note*: a = ICMA Survey of local government sustainability practices (2015); b = U.S. Bureau of Economic Analysis (2017); c = U.S. Census Annual Estimates of the Resident Population (2015); d = U.S. Bureau of Economic Analysis (2015); e = American Community Survey 5-Year Estimates (2015); f = U.S. Census Bureau Economic Census (NAICS Sector 31–33) (2012); g = EPA Environmental Dataset Gateway (EDG) (2014); h = CQ Press U.S. Political Stats (2018). Missing observations in Manufacturing Value Added: information withheld by the U.S. Census Bureau to avoid disclosing data for individual companies.

sustainability action. Second, observations at the county level offer practical advantages in terms of data collection and analysis since geographic boundaries of counties are clearly defined and remain relatively fixed over time (Isserman et al., 2009; Lobao et al., 2012). This allows us to control for a variety of confounding factors such as air quality and value added by manufacturing while maintaining the necessary comparability across units.

As for our independent variable, past industrial transitions, we rely on shifts in the percentage of manufacturing jobs of entire workforce at the county level from 1969 to 2016, the maximum range of historical industrial employment data that is publicly available from the U.S. Bureau of Economic Analysis. In the context of this analysis, shift in manufacturing employment is considered a valid proxy for industrial transitions from goods processing to information and service processing in a county (Kasarda, 1989; Kletzer, 2005). While previous studies have explored the impact of manufacturing concentration on local sustainability action (e.g., Krause, 2011; Sharp et al., 2011), they tend to use single-year observations and thus are less suited to assess the impact of historical trend or volatility.

As noted previously, two aspects of past industrial transitions are considered: historical trend and historical dispersion, assessing the direction and magnitude of local industrial transitions, respectively. To measure the direction of past industrial transitions, we follow a nonparametric approach given the lack of a consistent distribution in the percentages of manufacturing jobs in our sample (i.e., only 51 out of the 320 counties in our sample are identified to have normal distributions; $\alpha = 0.05$ using the Shapiro–Wilk test [Shapiro and Wilk 1965]). Specifically, a categorical variable based on the Mann-Kendall Statistic (MKS; Mann, 1945; Kendall 1948) is used to construct the different types of trends in the shifts of the percentages of manufacturing jobs. The Mann-Kendall trend test is a commonly used non-parametric trend detection method that takes into consideration the correlation between the observed values and their order in time (Hamed and Rao, 1998). Here, a significantly positive MKS indicates an ascending trend, a significantly negative MKS indicates a descending trend, and a non-significant MKS indicates no trend (coded 0 if no trend; 1 if descending trend; 2 if ascending trend). In our sample, 257 out of 320 counties are identified with descending trends while 43 are with ascending trends ($\alpha = 0.05$). As for historical dispersion, the standard deviation of percentages of manufacturing jobs over time at the county level is used as a proxy to assess the magnitude/pace of historical industrial transitions in each county.

Regarding the two moderating variables, we likewise rely on data from the LGSP survey. Specifically, for local governments' priority, we use responses to the question: "If environmental protection is a priority in your jurisdiction?" and set a dichotomous variable to 1 if a local government responded "yes" and 0 if "no." About local governments' disaster experience, we use responses to the question: "Has your local government had to respond to a major disaster in the past 15 years?" and again code a dichotomous variable to 1 if the response is "yes" and 0 if "no." Here, possible disasters include hurricane, tornado, flood, blizzard or ice storm, toxic spill, earthquake, wildfire, and drought.

Following pertinent studies in the literature, we also include several control variables that are potentially relevant for explaining variation in local governments' sustainability commitments. First, additional resources and administrative capacity associated with increased public service demand in larger counties might enable participation in sustainability programs (Ho and Ni, 2004; Walker, 1969). Population size and per capita income are thus controlled for at the county level given their potential impact on a county government's willingness and capacity to undertake sustainability programming. Likewise, educational attainment is generally considered as a factor motivating local government's sustainability action given its correlation with public awareness of and engagement with sustainability and environmental concerns (Krause, 2011; Meyer, 2015). Educational attainment also signals a local government's additional capacity that is necessary for sustainability action (Zahran et al., 2008a).

Furthermore, local environmental conditions are often used in studies on government sustainability-related decision-making since they are considered useful to localize broader environmental issues and to justify governmental actions through potential improvements in these conditions (Harlan and Ruddell, 2011; Kousky and Schneider, 2003). Accordingly, air quality is controlled for at the county level. Value added by manufacturing at the county level is controlled for, as well, in line with previous work that has demonstrated that presence of manufacturing might hinder participation in climate and broader

sustainability initiatives at the local level (Krause, 2011). As the literature suggests that political ideology affects environmental policy preferences, even when trust in government is controlled for (Konisky et al., 2008), we likewise control for political ideology. Lastly, research has found that, in the U.S., minority communities are particularly vulnerable to negative environmental impacts and experiencing greater environmental injustice (McDonald and Jones, 2018; Pearson et al., 2018). This might affect certain local governments' willingness to undertake sustainability actions. Percent of minority (non-white) residents at the county level is thus controlled for in our model.

## 4. Empirical analysis and results

The current analysis focuses on the influence of past industrial transitions on present-day sustainability programming at the county level in the U.S. In doing so, this analysis also examines the potential moderating effects of local governments' priority and disaster experience on the relationship between past industrial transitions on present-day sustainability commitments. Considering the binary nature of our dependent variable (i.e., adoption of a sustainability plan or not) and following common practice in the literature (e.g., Guo and Ba, 2020; Ho and Ni, 2004; Krause et al., 2016; Sharp et al., 2011), we rely on logit models and analysis of marginal effects for empirical analysis.

In total, we run six regressions with different specifications. First, the two independent variables measuring local industrial transitions—historical trend and historical dispersion—are introduced into the model separately along with all the control variables to explore their individual correlations with the likelihood of a county government adopting a sustainability plan (Models 1–2). The two independent variables are then introduced together so as to detect their singular effects while controlling for the other (Model 3). Prior to regressions, variance inflation factors (VIF) were calculated, and no severe multicollinearity problem was detected (average VIF = 2.37, see Appendix 1).

Regression results of Models 1–3 are presented in Table 2, where we report the estimated odds-ratios along with t-statistics (in parentheses). Here, an odds-ratio greater than 1 indicates a positive relationship between the variable of interest and the likelihood of a county government adopting a sustainability plan, whereas an odds-ratio<1 implies a negative relationship, holding all other variables constant. Following Zhang et al. (2020), we report t-statistics instead of standard errors to ease interpretation. In logit models, standard errors are difficult to interpret directly alongside odds ratios whereas a t-statistic can show the extent to which a point estimate is away from the null value.

**Table 2**
Results of logit regressions Models 1–3: Historical industrial transitions and local sustainability planning.

| Variables | | Model 1 | Model 2 | Model 3 |
|---|---|---|---|---|
| Independent Variable | | | | |
| Historical Trend | Descending | 1.784 (0.80) | | 2.332 (1.10) |
| | Ascending | 1.414 (0.39) | | 1.485 (0.43) |
| Historical Dispersion | | | 0.912 | 0.889* |
| | | | (−1.46) | (−1.66) |
| Control Variables | | | | |
| Population size | | 1.146 (0.61) | 1.147 | 1.042 (0.19) |
| | | | (0.71) | |
| Per capita income | | 1.483 (0.44) | 1.238 | 1.243 (0.24) |
| | | | (0.23) | |
| Education | | 0.976 | 0.976 | 0.974 |
| | | (−0.97) | (−0.97) | (−1.03) |
| Manufacturing Value Added | | 0.973 | 1.008 | 1.048 (0.43) |
| | | (−0.22) | (0.08) | |
| Air Quality | | 0.874*** | 0.93 | 0.931 |
| | | (−2.64) | (−1.12) | (−1.10) |
| Election | | 1.025* (1.93) | 1.024* | 1.026** |
| | | | (1.87) | (1.97) |
| Minority | | 1.01 (1.13) | 1.01 (1.05) | 1.007 (0.84) |
| Baseline Odds | | 0.004 | 0.023 | 0.021 |
| | | (−0.59) | (−0.4) | (−0.41) |
| N | | 289 | 2013 | 2013 |
| Pseudo R2 | | 0.052 | 0.057 | 0.063 |
| BIC | | 414.731 | 407.188 | 416.095 |

*Note:* Reported are odds ratios. In parentheses are t-statistics. Robust standard errors are clustered by states. BIC: Bayesian information criterion. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Our regression estimates indicate that, when taken into consideration individually, neither historical direction nor historical dispersion significantly correlates with the likelihood of a county government adopting a sustainability plan (Models 1–2). Yet when included together, historical dispersion has a negative and statistically significant correlation with the likelihood of a county government adopting a sustainability plan (Model 3). Specifically, holding all else equal, one unit increase in historical dispersion is associated with a 11.1% decrease in the odds of a county government adopting a sustainability plan. This implies that, when controlling for the direction of past industrial transitions, the probability of a county government undertaking sustainability commitments decreases as the magnitude of past industrial transitions increases. This provides limited support for our second hypothesis, that the magnitude of past industrial transitions is inversely related to local sustainability commitments in the U.S.

To further understand the relationship between past industrial transitions and local sustainability commitments, we build on Model 3 to introduce an interaction term between historical trend and historical dispersion (Model 4 in Appendix 2). We then analyze the average marginal effects (AMEs; Long and Freese, 2006) of past industrial transitions on the likelihood of a county government adopting a sustainability plan. Specifically, the AMEs of different types of Historical Trend are calculated and compared at different percentiles (10th – 90th) of Historical Dispersion to gauge if and how the effect of past industrial transitions varies. This approach is helpful given that the non-linear relationship between our dependent and independent variables (i.e., a logistic function) can complicate the interpretation of the interaction term. In other words, the marginal changes captured by the interaction term will vary based on the values in which the effects are being analyzed. AMEs are thus presented to illustrate the differential effects of past industrial transitions across different types of Historical Trend and at different levels of historical dispersion.

Fig. 1 illustrates the AMEs of historical trend on the likelihood of a county government adopting a sustainability plan calculated based on Model 4 at different percentiles of historical dispersion (see Appendix 3 for estimated coefficients). These estimates represent the correlation between the direction of past industrial transitions and the instantaneous probability of a local government committing to sustainability at different levels of transition magnitudes. Here, for either direction of past industrial transitions (i.e., ascending or descending), the AMEs of historical trend attenuates as the magnitude of transition increases. Such a finding provides further support for the negative relationship between historical dispersion and the likelihood of adopting a sustainability plan in our regression results (Model 3). Additionally, controlling for the magnitude of past industrial transitions, the AMEs of the descending trend are consistently larger than that of the ascending trend, indicating that, at the same pace of industrial transitions, counties experiencing a shrinking manufacturing workforce are more likely to adopt a sustainability plan than those that are experiencing a growing manufacturing workforce. This provides support for our first hypothesis, that the direction of past industrial transitions is inversely related to local sustainability commitments in the U.S.

We likewise explore the AMEs of local priority and disaster experience. Following the specification of Model 4, we first run two regressions that each has an interaction term between a moderating variable and historical dispersion (Models 5–6, see Appendix 4 for regression results). We then calculate the AMEs of each moderating variable at different percentiles (10th – 90th) of historical dispersion (see Appendix 5). Fig. 2 illustrates the AMEs of the two moderating variables on the likelihood of

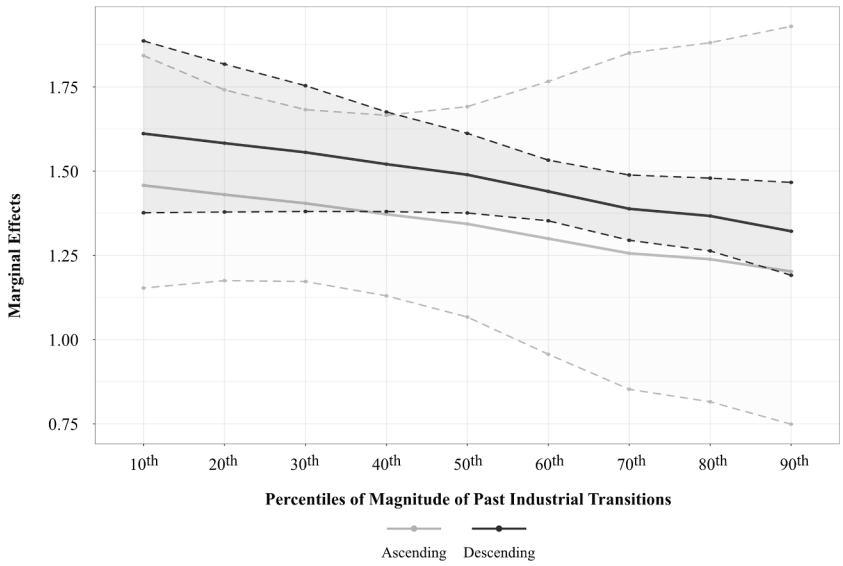


**Fig. 1.** AMEs of Historical Trend on the Likelihood of a County's Sustainability Commitment at Different Percentiles of Historical Dispersion. Shaded areas represent 95% confidence intervals ($\alpha = 0.05$).

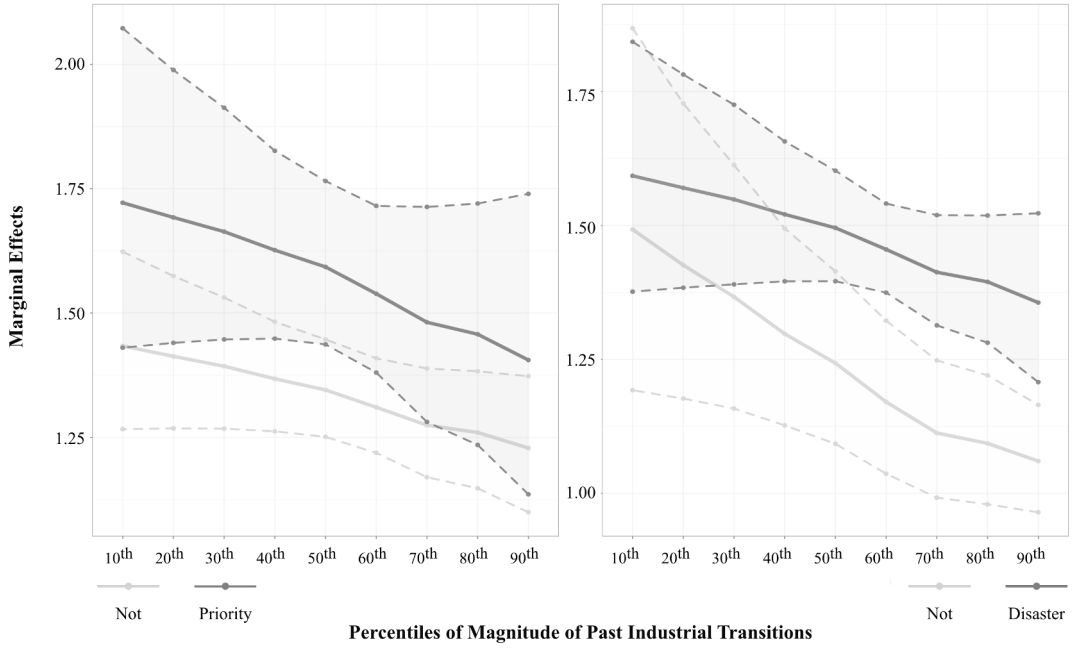


**Fig. 2.** AMEs of Moderating Variables on the Likelihood of a County's Sustainability Commitment at Different Percentiles of Historical Dispersion. The subfigures show the AMEs of local priority (left) and disaster experience (right), respectively. Shaded areas represent 95% confidence intervals ($\alpha = 0.05$).

a county government adopting a sustainability plan at different transition magnitudes. Specifically, the subfigure on the left shows that, when holding the magnitude of past industrial transitions at the same level, counties that view environmental protection as a local priority have larger AMEs than those that do not. This suggests the moderating effect of local governments' priority on the relationship between their past industrial transitions and present-day sustainability commitments. Along this line, the subfigure on the right shows that, when holding the magnitude of past industrial transitions at the same level, counties that have experienced a disaster have larger AMEs than those that do not, indicating the moderating effect of local governments' disaster experience. Together, the findings reported here provide support for our hypotheses 3 and 4.

## 5. Discussion and conclusion

Here, we assess whether historical variations in manufacturing employment within a given community are associated with the present-day sustainability commitment. The results largely confirm the association, suggesting the presence of latent community preferences that may be otherwise unobservable in contemporary data. In particular, this analysis finds that the magnitude of changes in manufacturing employment—the volatility observed within the manufacturing sector in a given place over time—is negatively associated with the probability of adopting a sustainability plan, with areas experiencing greater swings in employment over time being associated with lower probabilities of adoption. Particularly in counties with shrinking manufacturing employment, which represent the national trend (Charles et al., 2018)

and the majority of the sample (80.3%), our results suggest that those with more severe manufacturing job loss are less likely to adopt a sustainability plan.

While our regression analysis fails to find support for an association between the direction of manufacturing employment change and sustainability plan adoption, our analysis of the AMEs does indicate that, controlling for the pace of past industrial transitions, counties with a descending trend are more likely to adopt a sustainability plan than those with an ascending trend. Lastly, our analysis of local priority and disaster experience AMEs suggests that counties that view environmental protection as a local priority are more likely to adopt a sustainability plan and that counties that have experienced a disaster are more likely to do so, as well. Collectively, our analysis finds that both pace and direction of past industrial transitions matter in terms of local governments' sustainability commitments, and that the relationship between past industrial transitions and current local sustainability plan adoption can be moderated by local priority and disaster experience.

The findings of this analysis have implications for broader program development at the local level. From a program design and program targeting perspective, the findings suggest that inclusion of longer-term community attribute data—in this case, historical manufacturing volatility—can offer insight into community willingness to participate in sustainability-related policies or programming. The findings suggest that communities with a history of employment volatility may face additional barriers to sustainability programming than communities with less substantial swings in manufacturing employment. While the present analysis cannot affirmatively speak to the particular drivers of the association between past employment volatility and present sustainability planning, the findings do speak to the need to consider the mechanisms by which community history is translated into community practice.

These findings are particularly important given the recent attention in the literature to just and sustainable transitions. Though research suggests that retraining efforts can help communities transition to a clean energy economy with potentially minimal outlays by private or public entities (Louie and Pearce, 2016), the success of such initiatives is dependent upon the willing participation of affected communities. In this manner, the findings here also speak to the relevance of a wider scholarship in the development of policies and programs to both mitigate and adapt to climate change and to achieve sustainability. Recalling work by Cowie and Heathcott (2003), the role of community history and identity may be particularly relevant in the adoption of sustainability programming. Given the above findings that it is not only the direction but more importantly the pace of past changes that could matter in sustainability plan adoption, minimizing the rapidity of associated transition or job loss may counterintuitively ease the eventual adoption of sustainability-targeted policies, complicating efforts in the near-term.

Apart from the above contributions, there are several limitations of this analysis. First is the nature of the data and research design. The cross-sectional nature of our analysis prohibits causal inference. Future efforts with longitudinal data are thus encouraged to further this line of research. Second, this article endeavored to build upon the extant literature through the addition of theoretically-relevant parameters to tell a more complete story of sustainability program adoption. Even so, it is likely that there are other important variables omitted or alternative explanations for the mechanisms of action of those included here. The process by which employment loss trends and magnitude influence environmental programming is complex and far-reaching. For example, it is likely that local governments with high rates of increasing manufacturing capacity might have more resources to address environmental concerns than those that are transitioning to industrial economies at a relatively slower pace.

Future research should confirm and build upon the findings shown here. Though the analysis of employment trends is historical in nature, similar associations might hold for future transitions. Specifically, research should examine the interplay between employment trends and changing political dynamics, as well as their joint impact on local sustainability and community development actions. Comparative studies within developed economies and between developed and developing economies would be helpful so as to probe the challenges and benefits of inter- and intra-system policy design and implementation. Comparative analysis of the type of industrial transition is likewise necessary to assess whether present-day sustainability plan adoption is correlated with either the nature of the industry (e.g., carbon intensive, labor intensive) or the nature and motivation of the transition itself (e.g., 'offshoring' to another location, decline of industry as a whole). For example, research might explore the recent and continuing trend of job loss in coal producing areas to assess both the incidence and willingness of communities to adopt clean energy- or climate-related programming given the particular salience of transitions in these sectors and geographies at the present time. Lastly, our analysis considers only the binary adoption of sustainability plan. Dynamic models capable of capturing local sustainability actions across time may further contribute to the causal analysis of localized transitions.

### *CRediT authorship contribution statement*

**Yuhao Ba:** Data curation, Formal analysis, Methodology, Project administration, Validation, Writing – original draft, Writing – review & editing. **Christopher S. Galik:** Conceptualization, Methodology, Project administration, Supervision, Writing – original draft, Writing – review & editing.

### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

### Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.gloenvcha.2021.102421.

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